CIT3D Soccer Simulation Team Description for RoboCup 2011

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Abstract. This paper describes some main features of the CIT2011 3D soccer simulation team. After a brief introduction to CIT 3D team, the characteristics of CIT2011 3D soccer simulation team are represented. These include the following aspects: agent architecture, walking gait planning, and fast getting up action .Finally we make a summary of this work and our future research works are showed in this paper.

1 Introduction

CIT 3D team,formerly named CZU 3D, which was built in 2005, has taken part in serveral RoboCup competitions. We won the 13th place in RoboCup2006, the 2nd place in RoboCup ChinaOpen2007, the 4th place in RoboCup2008 and the 3rd place in RoboCup ChinaOpen2008. Due to various reasons, we could not participate in RoboCup2009 and RoboCup ChinaOpen2009, but we did not give up the research work in this field.In 2010,we won the 5th place in RoboCup ChinaOpen2010.

This paper introduces the features of our team. Section 2 offers a brief introduction to general framework of CIT agent. Section 3 introduces the skills of agent,include walking skill and fast getting up skill.Section 4 describes our localization method. In Section 5, we draw conclusions and present directions for future work.

2 Agent Architecture

After RoboCup 2008,we rewrote all program of our team, enhanced the readability and maintainability.The overall structure of our program is consits of many modules, such as AgentConnection, MsgParser, WorldModel, Decisions, Skills and so on.Non-single modules not only facilitate the development of the normal programming, but strengthen the flexibility, differentiation, and coordination between the agents. The agent architecture of our team is displayed in Fig. 1.

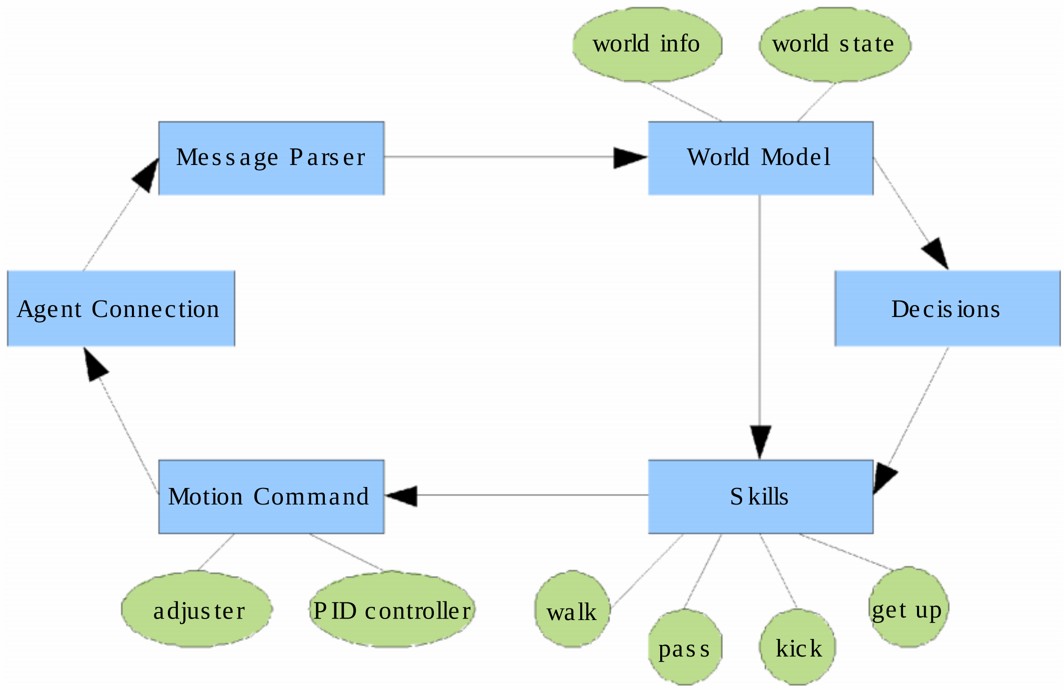

Fig. 1:CIT Agent architecture

3 Agent Skills

In this section, we introduce the skills of CIT agent. As we all know, it is difficult to create stable and smooth walking gait of humanoid robot. Thus,we give a lot of details about walking gait planning method of our agent. After the introduction of walking gait planning, we offer a brief description of fast getting up action.

3.1 Walking Model

Implementation of the agent's walking gait is the most difficult part and is the gist in the 3D simulation competition. The walking gait implementation become difficult because of the stability problem since a biped robot only has two legs and the stability is much compromised compare to a quadruped or hexapod.Walking gait is the steps taken by the biped robot to be able to walk. The walking gait of the biped robot is based on the walking gait of a human being. Based on human's gait pattern analysis,we could find the typical walking process of human can be divided into two phases:single support phase and double support phase.When the two phases alternately,forward movement is taken at the same time.The action above is repeated uninterruptedly while the body balance is kept and then, the walking function comes true. (See Fig.2)

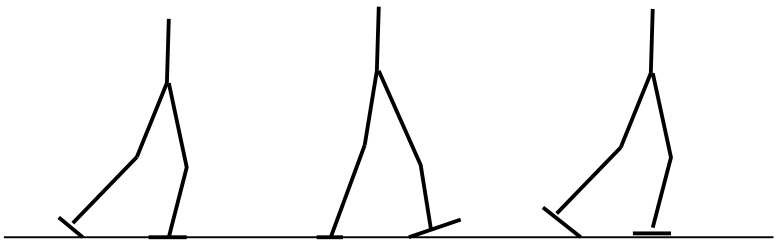

Fig. 2: The typical walking process

Fig.3 shows the walking model about a biped robot. (x_f, z_f) is the coordinate in the coordinate system,which is the walking trajectory point of *FOOT*.It describes the walking characteristics of a biped robot in the direction of x and z . l_{th} is the length of thigh, l_{sh} is the length of crus.

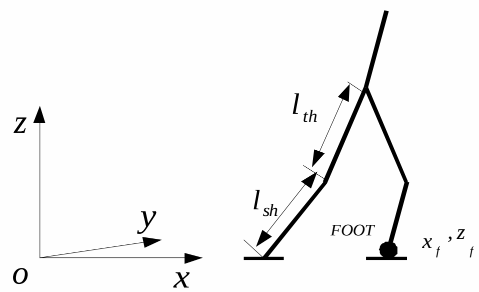

Fig. 3: The walking model about a biped robot

As illustrated in Fig.4,*T* represents the time of one step,*stepDistance* represents the length of one step,*HIP_Height* represents the height of hip joint to the ground during the double support phase, *UpFoot_Height* represents the height to the ground when foot lifted during single support phase.

Suppose the equation (1) stands for the walking trajectory of *FOOT* in direction z . (**1**)

$$z(t) = a_0 + a_1 t + a_2 t^2$$

In Fig.4, the coordinate of point o,p,q is as follows:

$$O(0,0) \quad (\mathbf{2})$$

$$p(T/2, UpFoot\_Height) \quad (3)$$

$$q(T, stepDistance) \quad (4)$$

From the equations above, we can get a_0 , a_1 , a_2 as follows:

$$a_0 = 0 \quad (\mathbf{5})$$

$$a_1 = (4upFoot\_Height\text{-}stepDistance)/T \quad (6)$$

$$a_2 = 2(stepDistance\text{-}2\ upFoot\_Height)/T^2 \quad (7)$$

Therefore, we can write the walking trajectory of *FOOT* in direction *Z* as follows:

$$z(t)=((4upFoot\_Height\text{-}stepDistance)/T)\times t+(2(stepDis\text{-}2upFootHeight)/T^2)\times t^2 \quad (8)$$

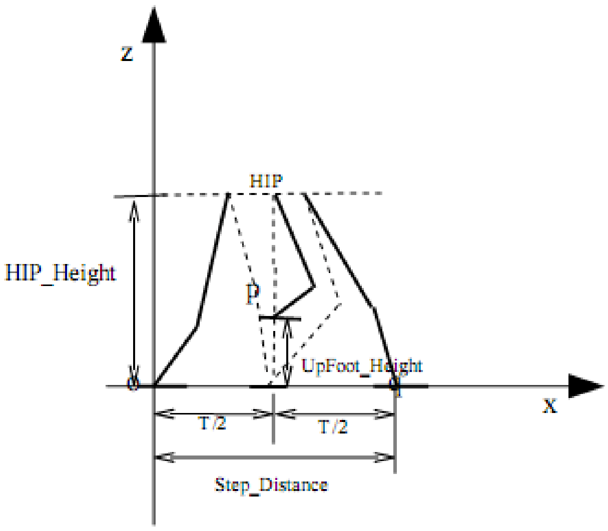

Fig. 4: The parameters of walking model about a biped robot

Suppose the equation of walking trajectory of *FOOT* in direction x is as follows:

$$x(t)=stepIncrement\times t \tag{9}$$

Where *stepIncrement* is the velocity of *FOOT* in direction x ,so we can get *stepIncrement* in equation (10).

$$stepIncrement= stepDistance/T \tag{10}$$

Finally, the equation of walking trajectory of *FOOT* in direction x is as follows:

$$x(t)=(stepDistance/T)\times t \tag{11}$$

From the equation (8) and (11),we can get all the coordinates of the walking trajectory point of *FOOT* in the direction of x and z .

Now assume that the feet of the robot are always parallel to the ground during the process of walking.(see Fig .5).

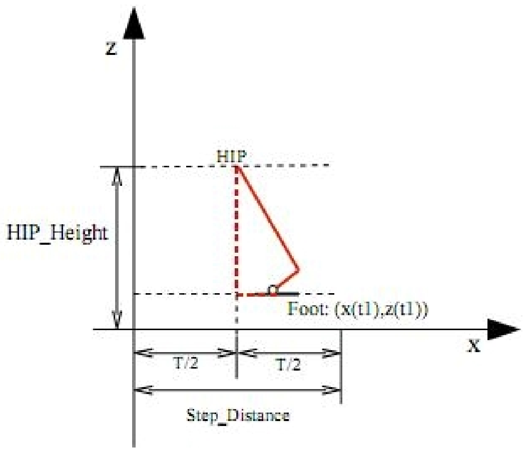

Fig. 5:A simple walking model about a biped robot

From the Red border quadrilateral in Fig .5,we can get quadrilateral ABCD,as showed in Fig .6.

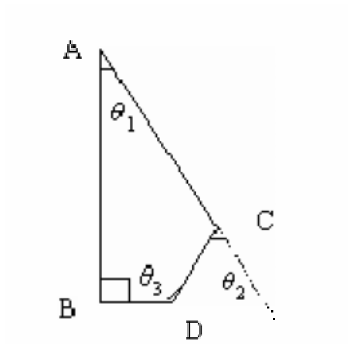

Fig. 6:The angles of leg joints during walking of a biped robot

Where AC=l_{th}, CD=l_{sh} ,AB=HIP_Height-z(t),BD=x(t)-stepDistance/2.Then by the knowledge of geometry, we can easily calculate the angles of $\theta_1, \theta_2, \theta_3$.In this way,the angles of leg joints can be obtained during the process of walking.

In the RoboCup 3D simulation environment,agents can send the angle command to the soccer server by joint effectors.Once the server get the messages,it will do physics update.Thus,the agent can walk to the desired destination. Our approach generates smooth walking trajectory, the robot walks stably and fast.(see Fig .7).

Fig. 7: The walking phases of CITagent

3.2 Getting Up Action

Getting up action have a direct impact on the performance of a 3D simulation team.Hence,we also do a large number of studies on it.As getting up action is off-line action,we encapsulate the action which created by debugger.In the simulation competition, agent can call the action directly.A good getting up action should be stably and rapidly.Inspired by the getting up action of human,we design our own getting up action,as showed in Fig .8.This action needs about 1.6 seconds,and has a strong anti-interference capability.

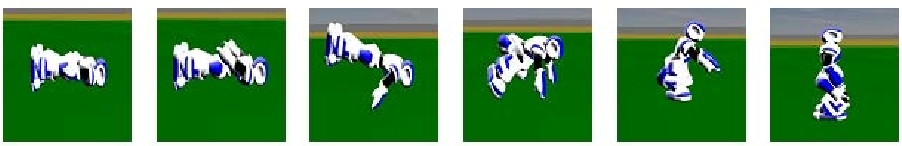

Fig. 8: The getting up action of CIT agent

4 PID Controller

After obtained the angles of leg joints during the process of walking by the above-mentioned method,if just directly send the angle command to the soccer server,we found there would be an error between given angle and actual angle of joint after several cycles.Therefore,we need a good method to correct the error between a measured angle and a desired angle.We design a PID controller to the angle of joint to compensate the error and it work perfectly.

5 Conclusion and Future Work

In this paper, we offer an introduction to the current status and some main achievements of our CIT2011 team. In the coming time, we will improve the motion and actions of agent, for instance, making the agent pass the ball faster, closely cooperating with each other among the teammates and etc.By this, our CIT2011(3D) will get very powerful.

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